An Analysis of Physical Activity Levels of Children Following the Balanced School Day Schedule

by

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ABSTRACT

Background: Physical activity is a key determinant of children's health. However, increasingly children are not attaining adequate amounts of physical activity. Children spend a considerable amount of time at school and school-based physical activity can significantly contribute to total daily physical activity achieved by children. Specifically, recess time can significantly contribute to a child's daily opportunity to attain the recommended 60 minutes of physical activity per day. In this thesis, I assessed the impact of block scheduling on physical activity levels during recess for children in grades 3 and 6. More specifically, I examined the impact of time of day (am vs. pm) and season (fall vs. winter) on levels of recess-based physical activity among children using the "Balanced School Day" schedule.

Methods: Data were collected at a school using the Balanced School Day schedule over five consecutive days during fall and winter in a school from a community in northern Ontario. Children wore the Yamax SW-200 pedometer and a segmented data collection approach to assess step counts during 'class-time' and 'recess-time' was used.

Results: Seventy-eight students participated in this study. Average daily steps were higher in the fall compared to the winter. There were no meaningful differences in the number of steps taken when considering time of day. Boys accumulated significantly more steps than girls for total recess steps regardless of season. Grade 3 students experienced the greatest decrease in steps seasonally.

Conclusions: As a result of this study, we have reaffirmed that children are not maximizing opportunities for physical activity during the school day. In general, lower step counts are noted among girls and grade 6 students. We can also conclude that the recess schedule (i.e. morning vs.

afternoon) does not affect physical activity during recess in children using the BSD; however, there is a seasonal influence. All children were less active in the winter recess when compared to the fall and this was particularly accentuated among the younger participants.

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CO-AUTHORSHIP STATEMENT

Chapter III is presented as a manuscript for publication.

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CHAPTER I

INTRODUCTION

1.1 Introduction

According to the World Health Organization (WHO), the prevalence of obesity has nearly doubled since 1980 (WHO, 2014a). Canadian boys and girls have experienced an increase in obesity rates from 2 to 10% and 2 to 9% respectively (Katzmarzyk, Tremblay, and Wilms, 2002). In addition, Whitaker and colleagues (1997) reported that the probability of obesity persisting into adulthood doubles for obese children, while only 10 percent of non-obese children will become obese as adults. Thus, addressing obesity during childhood is of utmost importance. Specifically, rising obesity rates have resulted in monumental increases in Type NIDD diabetes among youth (Roberts, Shields, de Groh, Aziz & Gilbert, 2012) and have increased the prevalence of numerous cardiovascular risk factors such as insulin resistance, hypertension and dyslipidemia in children and adolescents (Andersen et al., 2004). Given the relative importance of maintaining a healthful weight during childhood, further understanding the elements that influence obesity is crucial.

Childhood obesity is the result of many factors, including biological, psychosocial, sociological and behavioural correlates (Kimm & Obarzanek, 2002). This study focuses on the behavioural factors, which influence childhood obesity, specifically physical activity. Much of childhood obesity results from an imbalance between energy intake and energy expenditure (Chou, Grossman & Saffer, 2002). As physical activity results in energy expenditure, child access to and participation in frequent bouts of physical activity is essential for healthy weight achievement.

Physical activity guidelines for children in Canada were first developed in 2002 (Canadian Society for Exercise Physiology [CSEP], 2011). These guidelines outlined that regardless of current health status, all children should increase their physical activity level by a minimum of 30 minutes of moderate-to-vigorous physical activity (MVPA) per day, and should progress to an additional 90 minutes per day over the next 5 months (CSEP, 2011).

Based on a systematic review of the scientific evidence related to these guidelines, the Canadian Society for Exercise Physiology (CSEP) released a new set of physical activity guidelines for children in 2011 (Tremblay et al., 2011). These new guidelines were developed via the cooperative efforts of international representatives, content experts, stakeholders and an independent international panel over a 3-year period (2007-2011) (Kesäniemi, Riddoch, Reeder, Blair & Sorenson, 2010; Tremblay et al., 2011). One of the most significant changes in the guidelines included the adaptation of age categories in an effort to focus on a wider age group of the pediatric population. The initial guidelines categorized children as those aged 6-to-9 years, and youth as those 10-to-14, while the new guidelines now classify children as those aged 5-to-11 years, and youth as those aged 12-to-17 year (Tremblay et al., 2011). This age change allowed for the inclusion of 5 year-old children and adolescents from 15-to-17, broadening the application of the guidelines.

These new guidelines specify that children and youth should accumulate a minimum of 60 minutes of moderate-to-vigorous intensity physical activity on a daily basis (Tremblay et al., 2011). Moreover, the 2011 guidelines also specify criteria for this physical activity that were not specified in the 2002 guidelines. In particular, children and adolescents should participate in moderate-to-vigorous physical activity (MVPA) at least 3 days per week and children and adolescents should participate in muscle and bone strengthening physical activity at least 3 days per week (Tremblay et al., 2011). These daily bouts of physical activity can be accumulated at any time throughout the day. However as children and adolescents spend nearly one third of their waking hours in school (Gauthier et al., 2012), physical activity patterns during this time frame are important to consider and to further understand in order to determine their potential contribution to child health.

Along with the new recommendations for physical activity, CSEP has also developed sedentary guidelines for Canadians (2015). These guidelines indicate that while increasing physical activity levels, children and adolescents should also try to limit sedentary time throughout the day. More specifically, this should be accomplished by limiting screen time to no more than two hours per day and by limiting sedentary transport when possible. The aim of these sedentary guidelines is to lower levels of sedentary activity as when combined with more physical activity it associated increased health benefits (CSEP, 2015)

Recently, researchers have highlighted the possible implications of modified school schedules on physical activity levels (Dorman, Gauthier, & Thirkhill, 2013). Typically, school scheduling referred to as the Traditional School Day (TSD), offered three opportunities for recess-based physical activity. However, since 2002 many administrators have adopted what is known as the Balanced School Day (BSD); a new school schedule proposed by Micheal Walmsley, a principal within the Peel District School Board of Ontario (Shantz, 2005; Woehrle, Fox, & Hoskin, 2008). There have been several general claims of improved health outcomes as a result of this modified schedule, including potentially better opportunities for increased physical activity (Halton District School Board; 2003; Walmsley, 2001). Many school boards currently using any form of the BSD schedule indicate that it provides more time for physical activity and improves student physical fitness (Ottawa Carleton Assembly of School Councils, 2012; Rainbow District School Board, 2006; Waterloo Region District School Board, 2014). However, in a study by Gauthier and colleagues (2012), students using the BSD accumulated significantly fewer steps throughout the school day than those using the TSD, putting the statement that the BSD improves student physical fitness into question.

The Balanced School Day offers students three 100-minute teaching blocks separated by two 40-50 minute nutrition and physical activity breaks. During the past decade, many school boards throughout Ontario, Manitoba and Alberta have adopted the BSD schedule (Dorman et al., 2013). Early adopters of the BSD have reported benefits such as improved student concentration and classroom behaviour, as well as cleaner schools (Woehrle, Fox & Hoskin, 2008).

Woehrle and colleagues (2008) also surveyed principals, caretakers, parents, teachers, secretaries and students and revealed several interesting findings. For example, teachers felt they had more instructional time than with the TSD, and rated the organization of time as high (4.83 out of 5), yet teachers reported that primary students were tired and unable to focus on tasks at the end of the day. Principals also indicated that there were fewer behaviour problems when schools were using the new BSD, compared to when the TSD was in effect. Students in primary grades indicated that they had ‘sufficient time to play outside during recess’ more frequently when using the BSD compared to the TSD, yet those in intermediate grades did not. Overall, results from the survey focused on the satisfaction of all persons affected by the new balanced school day schedule, and revealed, on a scale from 1-5, that principals approved the most (4.8), followed by caretakers (4.1), parents (3.8), teachers (3.5), secretaries (3.3), and finally, students (3.0).

However, Chater & Lafond (2003) reported that the BSD decreased student attention, led to poorer student nutrition, teacher burnout and most relevant to the present research thesis, less time for physical activity. Clearly the health benefits of the BSD, particularly its impact on levels of physical activity, remain unclear. Such contradictory information prompted Gauthier et al. (2012) to empirically assess levels of physical activity in students using both the BSD and the traditional school schedule. Results from their study suggested that children using the traditional school schedule accumulated significantly more steps than those using the BSD. Throughout the entire school day students using the BSD accumulated an average of 6357 steps, compared to students using the traditional school schedule who accumulated 6788 steps (Gauthier et al., 2012). However, this study has one important limitation; the researchers assessed cumulative step counts throughout the entire school day and could not confirm that the difference reported between the two schedules was actually a result of variations in step counts taken by children at recess time.

In addition, Ball and colleagues (2009) found that more frequent bouts of physical activity are more beneficial for increased child physical activity. They observed that children are most active for the first ten minutes of active play, regardless of the length of time available. When considering school schedule, this logic would favor the traditional school day, which offers three periods of recess rather than the BSD, which offers only two. Although both school schedules offer relatively the same total recess time this reasoning may indicate that students using the BSD may accumulate significantly less physical activity during recess compared to those using the traditional school schedule.

Despite the limited evidence to support the implementation of the BSD, this new schedule has been widely implemented in schools across the province of Ontario. In general, a balanced schedule would mean students are receiving an evenly distributed amount of physical activity throughout the day; however, to date no study has actually empirically assessed if this is occurring. Thus, the general purpose of this thesis is to assess levels of physical activity among children using the ‘Balanced School Day’ by applying a segmented day approach to isolate recess time.

CHAPTER II

REVIEW OF LITERATURE

2.1 Health Benefits of Physical Activity

2.1a Physical Benefits of Physical Activity

Recent research has indicated that physical activity is associated with numerous health benefits in school-aged children (Janssen & LeBlanc, 2010), and several observational studies have suggested the relationship between physical activity and health appears in a dose-response fashion (Biddle, Gorely, & Stencel, 2004; Janssen & LeBlanc, 2010). When people participate in exercise several times per week or more, the musculoskeletal, cardiovascular, endocrine, immune and respiratory systems of that person undergo adaptations to increase capacity and efficiency, resulting in a healthier human being (Surgeon General, 1996). More specifically, those who are physically active have reduced rates of morbidity and mortality (Barlow et al., 1996; Beunen et al., 2007; Kaprio, Koskenvuo, Kujala, & Sarna, 1998), and possess a reduced risk of developing chronic diseases (Arnett et al., 2005; Boreham & Riddoch, 2001) such as Type 2 diabetes (Roberts et al., 20120), cardiovascular disease (Andersen et al., 1998), and osteoporosis (Bailey, Crocker, Faulkner, Mirwald, & McKay, 1999; Beck et al., 2002). Despite such undeniable evidence, in 2009, 75% of high school boys, and 89% of high school girls did not attain healthful amounts of physical activity (Eheman et al., 2012). Furthermore, the importance of this widespread decline in physical activity, which clearly results in the burden of major health complications, is often undervalued (Braun-Fahrländer et al., 2006).

2.1a.1 Obesity and Disease

The prevalence of overweight and obese children has become so widespread in developed countries that it is now commonly referred to as an epidemic (WHO, 2014b), and the rates have been rising. For example, between 1981 and 1996, rates of obesity in children aged 7 to 13 have increased from 5 to 15% (Tremblay & Wilms, 2000). Obesity, which is characterized by abnormal or excessive fat accumulation, is linked to the leading cause of deaths globally, namely cardiovascular illness and associated risk factors such as hypertension.

Unfortunately, childhood obesity leads to numerous adverse proximal and distal health outcomes including coronary heart disease and stroke, osteoarthritis, pulmonary disease (WHO, 2014b), high cholesterol and triglycerides, hypertension, insulin resistance (Freedman, Dietz, Srinivasan, & Berenson, 1999), Type 2 diabetes (Weyer et al., 2001), metabolic syndrome, polycystic ovarian syndrome, non-alcoholic fatty liver disease (Cruz, et al., 2003), as well as breast and colorectal cancer (Calle & Kaaks, 2004). In addition, childhood and adolescent obesity are strong predictors of adult obesity (Whitaker, Wright, Pepe, Seidel, & Dietz, 1997), meaning obese youth are highly likely to become obese adults, further accentuating the negative impacts of obesity on morbidity and mortality (Spruijt-Metz, 2011).

2.1a.2 Physical Activity and Type 2 Diabetes Prevention

In order to fully appreciate the positive health effects of physical activity, we should look more closely at the specific effects it has on disease prevention. Physical activity has been inversely associated with Type 2 diabetes (Taylor, Ram, Zimmet, Raper, & Ringrose. 1984). Specifically, physical activity lowers weight, and weight loss reduces the risk of developing Type 2 diabetes (Panel, 1998; Maggio & Pi-Sunyer, 1997). Physiologically, it has been reported that physical activity increases sensitivity to insulin (Helmrich, Ragland, Leung, & Paffenbarger, 1991; Soman, Koivisto, Deibert, Felif, & DeFronzo, 1979), which in turn improves cell uptake of glucose from the blood and blood glucose control (Panel, 1998; Maggio & Pi-Sunyer, 1997; Raumarmaa, 1984). The blood glucose effects of physical activity have been found in both those with and without Type 2 diabetes (Thompson, Sheeshka, & Manore, 2007). Helmrick and colleagues (1991) suggested that physical activity may protect against the development of type 2 diabetes by aiding in the maintenance of proper balance of lean to fat body mass. Steinberger and Daniels (2003) suggested that weight control and lifestyle modifications in childhood can reduce the risk of the development of type 2 diabetes , insulin resistance syndrome, and cardiovascular disease, further exemplifying the importance of regular, adequate physical activity in childhood. This relationship between obesity and type 2 diabetes is further exemplified when considering that the recent increase in type 2 diabetes parallels rising rates of childhood obesity (Amed, Daneman, Mahmud & Hamilton, 2010).

2.1a.3 Physical Activity and Cardiovascular Disease Prevention

Globally, cardiovascular disease is the leading cause of mortality (WHO, 2013), and has recently been described as a pediatric issue, as the onset occurs in early childhood even though the clinical symptoms do not generally appear until adulthood (Froberg & Andersen, 2005). Sedentary behaviour, learned in childhood and established as a norm by young adulthood, is a major contributor to the development of cardiovascular risk factors, including hypertension, atherosclerosis (Kannel & Dawber, 1972; Webber, Srinivasan, Wattingney, & Berenson, 1991), high cholesterol, high triglycerides, and abdominal fat (Froberg & Andersen, 2005). Conversely, numerous studies have outlined that physical activity can mitigate the risk factors of cardiovascular disease including: increasing high-density lipoproteins, lowering triglycerides, improving heart strength, lowering blood pressure, lowering body fat and weight, inhibiting progression of atherosclerosis, and improving blood glucose levels (Thompson et al., 2007).

Epidemiologic studies have confirmed that multiple risk factors greatly increase the probability of negative cardiovascular events, since cardiovascular risk factors seem to reinforce each other and their influence on morbidity and mortality (D'Agostino et al., 2008). Of concern, this clustering of risk factors has been detected in early childhood (Bao, Srinivasan, Wattigney, & Berenson, 1994; Khoury et al., 1980; Smoak et al., 1987; Webber, Voors, Srinivasan, Frerichs, & Berenson, 1979) and carries on into adulthood (Dietz, 1998). When considering the immense negative impact that atherosclerotic cardiovascular disease has on western societies, understanding when the disease begins to develop is vital (Steinberger & Daniels, 2003),

Many studies have found a positive association between: healthy blood pressure, a protective factor against cardiovascular disease; physical activity and physical fitness (Boreham, Twisk, Savage, Cran, & Strain, 1997; Fraser, Phillips, & Harris, 1983; Harrell et al., 1996; Hofman, Walket, Connelly, & Vaughan, 1987; Jenner, Vandogen, & Beilin, 1992; Panico et al., 1987). Attaining a healthy blood pressure during childhood via physical activity is vital as blood pressure has been seen to increase with age (Jureidini et al., 1988) and there is a negative relationship between blood pressure and body composition (Becque, Katch, Rocchini, Marks & Moorehead, 1988; Brownell, Kelman, & Stunkard, 1983), as blood pressure increases with body size (Lauer, Burns, & Clarke, 1985). Additionally, relatively high blood pressure has been observed in children with a family history of high blood pressure, putting some children at a greater risk of cardiovascular disease (van Hooft, Hofmen, Grobbee, & Valkenburg, 1988).

Higher blood pressure and poorer lipoprotein profiles are directly influenced by an increase in central body fat due to overweight and obesity (Bengtsson et al., 1984; Bernstein et al., 1985). This increased blood pressure can cause unhealthy stress on both the heart and the blood vessels themselves; raising the risk of atherosclerosis, thrombosis, aneurysm (Cronenwet et al., 1985), myocardial infarction (Robins, 2012), left ventricular hypertrophy (Uribina, 2008; Zeier, Geberth, Schmidt, Mandelbaum, & Ritz, 1993), kidney failure (Agarwal & Anderson, 2006; Sarnark et al., 2003), organ damage (Uribina et al., 2008), blindness (Schrier, Estacio, Esler, & Mehler, 2002), and stroke (O'Leary et al., 1999). Unfortunately, hypertension is commonly not visible, and can sometimes cause irreversible, even deadly, damage. These health-deteriorating risk factors, which are directly linked to childhood obesity, are also associated with health problems in adulthood, independent of adult weight status (Bajema, Dallal, Dietz, Jacques, & Must, 1992; Berenson, Nicklas, & von Duvillard, 2002).

Along with blood pressure, lipoproteins play a vital part in cardiovascular disease as they control blood cholesterol and triglycerides, both of which play an important role in the pathogenesis of atherosclerosis (Andreoli, 2010); hence, healthy levels of these lipoproteins must be maintained for good health. High-density lipoproteins (HDL) are small lipoproteins which pick up cholesterol from the blood and return in to the liver, effectively removing it from the circulatory system (Thompson et al., 2007). Therefore, HDLs are associated with improved cardiovascular health. Chylomicrons and very-low-density lipoproteins (VLDL) transport triglycerides to the cells of the body, while low-density lipoproteins (LDL) transport cholesterol to the tissues of the body. Although necessary for proper functioning, high levels of LDLs, VLDLs and chylomicrons increase the risk of cardiovascular disease (Thompson et al., 2007). The body does need a sufficient supply of cholesterol and triglycerides, but an excess amount of these transporters results in an increased deposition on the inner walls of the blood vessels, increasing atherosclerosis and therefore also increasing the risk of cardiovascular disease.

Research has confirmed an association between blood lipids and physical activity in children, similar to that seen in adults; active children have healthier blood lipid profiles than inactive children (Whitney, Cataldo, & Rolfes, 2002). Lifestyle modifications are suggested as the initial step to control hyperlipidemia (Andreoli, 2010); regular, moderate physical activity has beneficial effects on coronary heart disease by altering serum lipids (Zorba, Cengiz, & Karacabey, 2011) as working muscles play an essential role in lipid metabolism by inducing a number of positive changes in lipoprotein metabolism (Berg, Frey, Baumstark, Halle, & Keul, 1994). For example, exercise increases the production of lipoprotein lipase (LPL), which hydrolyzes triglycerides in chylomicrons and VLDLs, allowing the triglycerides to leave the blood and enter the body tissue to function as an energy source (Andreoli, 2010). Exercise also increases HDL concentrations (Andreoli, 2010; Berg et al., 1994), improving the body's ability to rid the body of cholesterol (Thompson et al., 2007).Furthermore, high-intensity exercise has been found to decrease serum LDL levels, effectively reducing serum cholesterol levels (Andreoli, 2010). It is clear that regular physical activity decreases the risk of coronary heart disease by lowering LDL and VLDL concentrations, and raising HDL concentrations, which in turn lowers serum cholesterol and triglycerides (Andreoli, 2010), a phenomena that is present independent of changes in body weight (Berg et al., 1994).

In sum, the relative risk of death from cardiovascular disease is approximately twice as high for those who had been overweight in adolescence regardless of their current adult body mass index (Bajema et al., 1992). Therefore, the prevention and the effective treatment of overweight and obesity in children are essential to combat cardiovascular disease morbidity (Whitaker, Wright, Dietz, Pepe, & Seidel, 1997).

2.1a.4 Physical Activity and Osteoporosis

The time periods of childhood and adolescence have been categorized as the most critical period of skeletal mineralization due to the fact that the amount of bone developed during these years is a major determinant for bone health later in life (Slemenda et al., 1994). One key factor that increases bone development during these vital years is physical activity; bone mineral accumulation is at its peak in highly active individuals (Bailey et al., 1999). Physically active individuals have greater bone mass due to the fact that during physical activity bones are stressed and counter this stress by building stronger, more durable bones; the stress of muscle contraction and impact during physical activity, specifically high-impact physical activity such as jumping (Janz et al., 2010), stimulates increased bone growth and density (Thompson et al., 2007). The bone health benefits of physical activity in childhood persist into adulthood, greatly influencing adult health and decreasing the risk of osteopenia and osteoporosis later in life (Bailey et al., 1999).

2.2 Psychological Benefits of Physical Activity

Between 10% and 20% of children and adolescents have behavioural and psychological problems and 7% need psychological treatment (Prior, 1992; Sonuga-Barke, Thompson, & Stevenson, 1997). Overall, exercise has been found to improve mental health by reducing depression, anxiety and negative mood, and by improving self-esteem and cognitive function (Callaghan, 2004). More specifically, systematic reviews of the literature indicate that physical activity has a positive influence on depression, anxiety, self-esteem and behavioural problems in children and adolescents (Biddle, 1993; Mutrie & Parfitt, 1998). Furthermore, mood states can have a profound influence on physical health (Byrne & Byrne, 1993); unfortunately, mental illness is of growing concern for children (Tolan & Dodge, 2005) but the good news is that physical activity and exercise can be used as interventions to help improve mental health in all individuals including children.

2.2a Physical Activity and Mood/Depression

Some empirical and anecdotal evidence show that physical activity may have an antidepressant effect on both healthy and unhealthy individuals (North, McCullah & Tran, 1990), as well as persons with disabilities (Green & Reid, 1999). Persons suffering from depression show a large decrease in depression symptoms when practicing regular physical activity (Lawlor & Hopker, 2001). Some research suggests that the biological link between physical activity and decreased depression lies in the secretion of neurotransmitters and hormones. Brosse, Sheets, Lett and Blumenthal (2002) suggested that physical activity stimulates the release of the neurotransmitter serotonin. Inadequate serotonin can result in widespread negative effects on an individual's attention and emotional states, and may be responsible for severe chronic depression (Martini & Nath, 2010). Also, animal studies suggest that physical activity stimulates the secretion of endogenous morphines, or endorphins, that produce a state of euphoria (Pert & Bowie, 1979).

2.2b Physical Activity and Anxiety

Aerobic exercise has been linked to a reduction in anxiety (Guszkowska, 2003), with long-term, regular physical activity showing greater positive outcomes than acute, or sporadic physical activity (Petruzzello, Landers, Hatfield, Kubitz, & Salazar, 1991). One theory proposes that the improvement is caused by an increased blood flow to the brain; with this increase in blood flow during exercise the hypothalamic-pituitary-adrenal axis, which controls the physiologic reaction to stress, reduces the rate of production and release of stress hormones, like cortisol (Guszkowska, 2003). This theory essentially indicates that exercising increases blood flow to the brain that can influence stress and alter mood in ways that decrease anxiety.

Another hypothesis, developed by Solomon (1980), is known as the 'Opponent-process Theory.' This theory suggests that every process that has a pleasant or unpleasant affect, is followed by a secondary ‘opponent process’, which occurs after the primary process is quieted. So, unpleasant states, like exercise, can still be rewarding. Exercise, stimulates the sympathetic nervous system, increasing levels of adrenaline, causing an arousing effect. This creates a corresponding relief from exercise that stimulates the parasympathetic nervous system, releasing acetylcholine, in turn resulting in a calming effect. Furthermore, physical activity is suggested to distract individuals from stressful events or thoughts, reducing the anxiety they cause (Bahrke & Mogan, 1978).

2.2c Physical Activity and Self-Esteem

Many studies have reported a strong relationship between physical activity and self-esteem (Barton, Griffin & Prett, 2012; Dishman et al., 2006; Gruber, 1986; McPhie & Rawana, 2012). Tremblay, Inman and Willms (2000) completed a study focusing on grade 6 students and reported two important findings. First, physical activity levels of students were significantly and positively related to self-esteem, even after accounting for socio-economic status. Second, increased participation in vigorous physical activity levels resulted in progressively improved self-esteem for both sexes.

Self-esteem tends to decline during adolescence, especially for females (Tremblay et al., 2000). Tremblay and colleagues (2000) suggested that participation in physical activity may help some youth prevail through the difficult transition into adolescence with positive self-esteem. Furthermore, girls and women who are physically active are less likely to smoke (Canadian Association for the Advancement of Women and Sport and Physical Activity, 2013). According to Stice and Shaw (2002), low self-esteem and weight concerns are strong predictors for smoking initiation in young women. In addition, low self-esteem and weight concerns are associated with physical inactivity (Elder et al., 2007; Jaffee, Mahle, & Lutter, 1995). This indicates that women who exercise regularly are less likely to smoke, and more likely to have healthy levels of self-esteem.

2.3 Factors that Influence Childhood Physical Activity

The current epidemic of overweight and obesity is largely caused by an environment that promotes excessive food intake and discourages physical activity (Jeffery, French, & Story, 2001). If insufficient physical activity is an important factor in the development of childhood overweight issues and obesity (Candel, De Meij, Jurg, Kremers, & Van Der Wal, 2006), then a key to ceasing its ascent lies in understanding the habits and trends of childhood physical activity.

When examined, it is evident that youth physical activity is a complex behaviour determined by many factors (Biddle, Atkin, Cavill & Foster, 2011). Past research suggests that these influential factors include perceived barriers, intentions to be physically active, preferences for physical activity, access to facilities and programmes, time spent outdoors, gender, participation in community sports, previous physical activity, parental support respecting physical activity, sibling physical activity, and opportunities to be active (Biddle et al., 2011).

Opportunities for physical activity during school can be intimately related to many of the above outlined determinants of youth physical activity levels. These include access to facilities and programmes, time spent outdoors and opportunities to be active. Given that school recess can account for up to 80% of recommended daily minutes of physical activity (if active during the entire recess period) (Gauthier et al., 2012); decisions regarding recess-based physical activity must not be taken lightly.

2.3a Physical Activity and School: Social Importance of School Recess

Elementary school children spend up to three hours per week outside during recess (Rainbow Schools, 2009a; Rainbow Schools, 2009b; Rainbow Schools, 2009c). This time is intended for students to attain a component of the recommended 60-or-more minutes of moderate-to-vigorous exercise per day (Centre for Disease Control and Prevention, 2011). Furthermore, recess provides children with a break from the academic challenges of class time (Janssen & LeBlanc, 2010).

Additionally, recess promotes social-emotional learning for children, offering them an opportunity to engage in social interactions to practice and role-play essential social skills (Ramstetter et al., 2010). Through play at recess children learn valuable communication skills, including negotiation, cooperation, sharing, and problem solving (Ramstetter et al., 2010). Children also develop intellectual ideas and cognitive understanding through hands-on experiences; these types of experiences occur regularly during play in an unstructured social environment (Ramstetter, Murray & Garner, 2010). Stellino and colleagues (2012) indicated that recess is a necessary part of the school day that allows children to develop personal and social responsibility, physical competence, health-related fitness and enjoyment of physical activity, which can permit them to become more physically active later in life. Considering the importance of all of these skills, recess scheduling must be better studied in an effort to obtain maximum positive outcomes for students.

2.3b Physical Activity and School: Academic Performance and Behaviour

Several studies have assessed the relationship between academic performance and physical activity in elementary schools; focusing on academic performance and classroom behaviour. These studies primarily indicate that recess-based physical activity has a positive relationship with attention, concentration, classroom behaviour, cognitive skills, attitudes, and academic behaviour; following recess children are more attentive and better able to perform cognitively (Bjorklund & Brown, 1998; Jarrett et al., 1998; Pellegrini & Smith,1993).

Fleshner (2000) suggests that physical activity may improve academic performance by increasing blood flow, in turn improving circulation to the brain, as well as increased release of norepinephrine and endorphins. It is thought that these changes improve academic performance by improving mood, reducing stress and inducing a post-physical activity calming effect that allows for greater concentration. This entails that after being physically active during recess, students are calmer and more focused, allowing them to excel academically. Conversely, children who do not take part in physical activity throughout the day exhibit higher energy levels and poorer concentration in classroom situations, decreasing their ability to excel academically (Taras, 2005).

The Cognitive Immaturity Hypothesis may explain the relationship between recess, classroom behaviour and academic performance. This theory suggests that optimal cognitive functioning in a child requires a period of interruption, following a period of concentrated instruction (Pellegrini & Smith, 1993). It is suggested that these interruptions are best served by unstructured breaks, such as recess, rather than alternating between one cognitive task and another; diminishing stressors and distractions that interfere with cognitive functioning (Jarrett, 2002). This means that recess breaks may provide enough of a break from structured learning to recharge the children and allow for greater concentration following the break. Furthermore, whether recess is performed indoors or outdoors, classroom behaviour and cognitive focus improve, as children become more attentive and productive when the day consists of recess breaks (Jarrett et al., 1998; Pellegrini, Hubertry, & Jones, 1995). Any type of activity during recess, even purely social activity, results in improved classroom cognition afterwards (Stellino & Sinclair, 2008).

It has also been reported in several recent studies that obesity is linked to poorer school performance and behaviour, a factor that can be avoided with regular physical activity. For example, Story and colleagues (2006) found that severely overweight children and adolescents are four times more likely than their healthy weight peers to report impaired school functioning. Datar, Sturm and Magnabosco (2004) examined 11,192 kindergarten children, and found that overweight children had significantly lower math and reading test scores than their healthy weight counterparts. In addition, it has been observed that overweight children are also more likely to have abnormal scores on the Child Behaviour Checklist and are twice as likely to be placed in special education or remedial classes than children who are not overweight (Tershakovec, Weller, & Gallagher, 1994).

These studies do not indicate that obesity and overweight cause poorer school performance and behaviour, but simply suggests that the two may be associated. For example, it has been shown that there is a link between obesity and health-related absenteeism (Silverstein et al., 2005). Children who are overweight experience higher rates of asthma, joint problems, sleep apnea, Type 2 diabetes, depression and anxiety (Must, Spadano, Coakley, Field, Colditz, & Dietz, 1999). Therefore, overweight children may be missing more school than their healthy weight counterparts due to secondary ill health effects of obesity, which in turn, leads to poorer academic performance.

Furthermore, the positive behavioural effects of physical activity are prominent in children with Attention-Deficit Hyperactivity Disorder (ADHD), as they display lower levels of inappropriate classroom behaviour on days when they are allotted recess time, compared to days without (Ridgway, Northup, Pellegrin, LaRue, & Hightsoe, 2003). As well, students with and without ADHD are ‘on task,’ and less fidgety on days when recess is provided (Jarrett et al., 1998).

2.3c Physical Activity and School: Time of Day Variations in Physical Activity

According to Colley and Garriguet (2012), children aged six-to-ten are most active from 11:00 AM to 1:00 PM, a time frame commonly parallel to the TSD lunchtime recess. In comparison, children using the Balanced School Day (BSD) are in class at this time and it is therefore unknown if the physical activity gained within this school schedule will be attained elsewhere throughout the school day. Assessment concerning time-based physical activity of children using the BSD is currently non-existent, therefore at present only assumptions can be made with respect to its influence on recess-based physical activity levels. Without the opportunity for physical activity between 11:00 AM and 1:00 PM, this peak in physical activity may be reflected across both the morning and afternoon recess breaks of the Balanced School Day; however, this is not ensured. Assessment of the physical activity pattern for children using the Balanced School Day is sparse, and should be completed to determine whether or not the Balanced School Day truly results in equal amounts of physical activity in the morning and afternoon.

2.3d Physical Activity and School: Seasonal Variation in Physical Activity

According to Chan, Ryan and Tudor-Locke (2006), it is important for program coordinators and policy makers to understand the effects that environmental factors have on physical activity levels. An environmental factor commonly overlooked in research concerns the effect of inclement weather on physical activity (Duncan, Duncan, Hopkins, & Schofielf, 2008).

According to Duncan and colleagues (2008) low temperatures, strong winds and heavy rainfall negatively contribute to outdoor physical activity, and may result in a decrease in overall energy expenditure. Given that children spend over 3 hours per week outside during recess (Rainbow Schools, 2009a; Rainbow Schools, 2009b; Rainbow Schools, 2009c), physical activity incurring during this time is sensitive to seasonal effects; which will vary amongst schools depending on their geographical location (Duncan et al., 2008).

Moreover, in developed societies, body fat commonly increases during the winter, with parallel changes in blood lipids, blood pressure and blood coaguability; changes that are commonly not reversed the following summer (Shephard & Aoyagi, 2009). This means that if children become more sedentary in winter months, they are more likely to remain sedentary in the future, and this may contribute to the development of a sedentary lifestyle and its related ill-health effects.

The Greater Sudbury Area faces a wide variation of weather during the elementary school year; from September averages of 12.3°C to January averages of -13.6°C (Environment Canada, 2014), and extremes as low as -39.3°C (Environment Canada, 2014). According to Chan and colleagues (2006), weather conditions can greatly influence outdoor activities, impacting daily step counts and overall energy expenditure. Warmer weather, such as the September average of 12.3°C (Environment Canada, 2014), results in an increase in steps per day (Chan, Ryan & Tudor-Locke, 2006). Chan et al (2006) also claim that an increase in weather by 10°C can result in a 2.9% increase in steps per day. Thus, weather during the school year within the area where this research was conducted can vary from a September extreme high of 31.1°C to a January low of -39.3°C (Environment Canada, 2014) a range that, according to Chan, Ryan and Tudor-Locke (2006) has the potential to alter steps taken per day by up to 20.4%.

These variations can impact a student's ability to attain adequate physical activity (Duncan et al., 2008) both throughout the school year and on a daily basis. The BSD provides only two opportunities for recess; if inclement weather results in the cancellation or reduction of time during one of these periods, opportunity for activity on that day will be hindered. Rain and extreme cold weather during one recess would cut BSD outdoor time in half, while the traditional school schedule, which offered three shorter time blocks for recess, would only be decreased by one third. The relative impact of seasonal variations on levels of physical activity in relation to the Balanced School Day schedule has not received attention; however according to this review of the literature, this issue certainly warrants investigation.

2.4 Purpose

Students who experience inadequate amounts of physical activity face serious health risks, such as obesity (Boreham & Riddoch, 2001; Boyle, Jones, & Walters, 2010; Janssen & Leblanc, 2010), high blood-lipid levels, poor self-efficacy and hypertension (Boreham & Riddoch, 2001; Jannsen & Leblanc, 2010); all of which may affect overall physical, psychological and social health. Furthermore, children who do not take part in physical activity throughout the day exhibit higher energy levels and poorer concentration in classroom situations (Taras, 2005). With these negative implications of insufficient physical activity levels, factors such as school scheduling should be assessed in an effort to optimize childhood physical activity levels during the school day. The purpose of this study was to assess the impact of time-of-day, as well as season, on physical activity levels for children in grades 3 and 6 using the Balanced School Day.

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CHAPTER III

ASSESSING THE INFLUENCE OF SEASON AND TIME-OF-DAY ON PHYSICAL ACTIVITY LEVELS DURING RECESS

Chapter III is presented as a manuscript for publication. The manuscript is published at the Global Journal for Health Education and Promotion (http://js.sagamorepub.com/gjhep).

Jaunzarins, B. T., Gauthier, A. P., King, K.D., Larivière, C., & Dorman, S.C. (2014). Assessing the influence of season and time-of-day on physical activity levels during recess. *Global Journal of Health Education and Promotion.*1(1), 62-75.

Abstract

Background: Recess time can significantly contribute to a child's daily opportunity to attain the recommended 60 minutes of physical activity per day. This study assesses the impact of block scheduling and season on physical activity levels during recess for children in grades 3 and 6.

Methods: Data were collected over five consecutive days during fall and winter in a school from a northern Ontario community. Children wore the Yamax SW-200 pedometer with a segmented data approach to assess 'class-time' and 'recess-time' step counts.

Results: 78 students participated in this study. Average daily steps were higher in the fall compared to the winter. There were no meaningful differences in the number of steps taken considering time of day. Steps accumulated during fall recess were significantly higher than during winter recess. Boys accumulated significantly more steps than girls for total recess steps regardless of season. Grade 3 students experienced the greatest decrease in steps seasonally.

Conclusions: These results suggest that differences in recess step counts are impacted by season; this may be particularly true for younger children. Strategies to mitigate these declines should be implemented.

Key Words: physical activity, children, time-of-day, season, recess, balanced school day

Review of Literature

The Canadian Physical Activity Guidelines recommend a minimum of 60 minutes of moderate-to-vigorous physical activity each day for children aged 5-11 (Canadian Society for Exercise Physiology [CSEP], 2011). Canadian researchers have also estimated that 12,000 steps per day is roughly equal to 60 minutes of moderate-to-vigorous daily physical activity (Colley, Janssen & Tremblay, 2013). Given that children spend roughly one third of their waking hours in school, this setting offers important opportunities for physical activity to achieve the recommended levels. During the school day, students divide their time between classroom and recess time. Each time period provides separate opportunities to accumulate the recommended daily physical activity. However, the levels and patterns of physical activity achieved during school hours are rarely explored in isolation from activity levels achieved outside the school setting. Given the current emphasis placed on schools to increase children's daily physical activity levels, further research is needed to fill this knowledge gap.

Students who experience inadequate amounts of physical activity face serious health risks (Boreham & Riddoch, 2001; Boyle, Jones & Walters, 2010; Janssen & LeBlanc, 2010) and children who do not take part in physical activity throughout the day exhibit higher excess energy levels and poorer concentration in the classroom (Taras, 2009). In this context, scheduled recess is important for both health and academic success. In Ontario, almost all school boards have now adopted the Balanced School Day (BSD) schedule. The BSD is a type of block scheduling wherein the school day is divided into roughly three 100-minute teaching blocks separated by two 40-minute nutrition/activity breaks. A consequence of block scheduling, like the BSD schedule, is that it creates fundamental alterations in the number, length and time-of-day that recesses are scheduled; specifically, schools now plan for two recesses, each 20-minutes in length, with the first being offered mid-morning and the second mid-afternoon. The cumulative 40 minutes of outdoor playtime are believed to be fundamental for students to attain a significant portion of the recommended 60 or more minutes of daily exercise.

In order to maximize the amount of physical activity children can achieve during school hours, close consideration of recess scheduling is warranted. For example, McWilliams and colleagues (2009) reported that children are more active when provided with shorter but more frequent bouts of physical activity compared to longer and less frequent opportunities to be active. More specifically, McKenzie and colleagues (1997) observed that children are most active for the first ten minutes of active play regardless of the length of playtime. This finding suggests that more frequent, shorter recesses would be more beneficial to maximize levels of physical activity at school. Also, according to Garriguet and Colley (2012), children aged six-to-ten are most active from 11:00 AM to 1:00 PM. In the context of the BSD, children are in class during this time frame. This suggests that time-of-day during which recess time is scheduled may impact the amount of physical activity that the children engage in.

The impact of inclement weather is a co-consideration when examining time-of-day effects and number of recesses to offer during school hours. According to Chan, Ryan and Tudor-Locke (2006), inclement weather can have a negative impact on physical activity, yet this factor is commonly overlooked in research (Duncan, Hopkins, Schofield & Duncan, 2008). A study by Duncan and colleagues (2008) has shown that low temperatures, strong winds and heavy rainfall negatively contribute to outdoor physical activity, and therefore can result in lower overall energy expenditure levels. Given that different geographical locations experience different climates, it is reasonable that school location will also impact children's physical activity Duncan et al, 2008). More specifically, children attending schools located in climates that experience more dramatic seasonal variations in temperature are likely to experience greater fluctuations in physical activity levels potentially impacting student health. It is also reasonable to envisage that physical activity levels may differ between morning and afternoon play periods particularly during the winter season when cold temperatures may prohibit out-door play in the morning. Given that the BSD schedule provides two opportunities for recess, in the morning and the afternoon, daily inclement weather could result in the cancellation of one or both of these recess periods. When expanding this concept to seasonal effects, repeated extreme-cold temperatures, particularly during the winter season, would hypothetically impact total physical activity more dramatically in winter compared to summer, spring or fall. This concept has not received considerable attention and merits further investigation.

Given the broad spectrum of physical capabilities and activity levels amongst elementary school-aged children from kindergarten to Grade 8, age-related differences in physical activity levels during recess time should also be considered when examining school recess schedules. Although the physical activity levels of children of all ages are reportedly impacted by inclement weather (Ball et al, 2009; Chan, Ryan & Tudor-Locke, 2006; Tucker & Gilliland, 2007), more detailed studies comparing recess physical activity levels between children from different age groups are lacking and therefore merit consideration.

The purpose of this study was therefore: i) to compare total daily step counts accumulated during class time, compared to recess-time; ii) to compare block scheduling effects on variations in step counts accumulated during morning and afternoon recess; and iii) to compare seasonal variations in step counts accumulated during recess for children in grades 3 and 6.

Methods

Study Design

Data were collected daily for five consecutive days during the fall (October) and winter (February) seasons from an elementary school in northern Ontario. All students in grade 3 and 6 at this school were asked to participate in the study. Parental/guardian information and consent forms were provided to each child's family prior to data collection. Student assent was obtained only from students who had received parental/guardian consent. This study was approved by the Research Ethics Boards from the authors' academic institution as well as the School Board in which this school was located.

Participants

Seventy-eight children (boys: 49; girls: 29) from grades 3 (n=37) and 6 (n=41) from our identified school agreed to participate; the response rate was 63%.

Instruments

The Yamax SW-200 pedometer was used in this study as it has been shown to be the most consistent and accurate pedometer (Tudor-Locke, Ainsworth, Thomson & Matthews, 2002). Multiple tests have demonstrated the lowest absolute value of percent error under free-living conditions (Le Massurier, Lee, & Tudor-Locke, 2004). Yamax guidelines were followed when utilizing the devices.

Procedure

Students were assigned a labeled pedometer prior to data collection and wore their identified pedometer throughout both data collection periods. During these data collection periods, students were exposed to their regular BSD schedule, which included a 100 minute classroom block, 40 minutes nutrition and recess break (20 minutes each), another 100 minutes of classroom block, a second 40 minute nutrition and recess break (20 minutes each), and a final 100 minute classroom block. Pedometers were attached to the waistband of participants by the researchers each morning and removed at the end of the school day. Each device was reset to zero upon attachment in the morning, and researchers collected step counts from the devices before and after the morning and afternoon recesses and at the end of each day, allowing for total daily step counts to be segmented into 'class time' and 'recess time'. Students were instructed not to touch their pedometers and were monitored throughout the day.

Data Analyses

Data were expressed as mean values ± SD. Mean scores were computed for continuous variables and compared using independent sample *t* tests and paired sample *t* tests. Independent sample *t* tests were computed when step counts for two groups were being compared (e.g. Grade 3 and grade 6 total recess steps for the fall). Paired sample *t* tests were used when comparing the same group of participants over two time periods (e.g. Grade 3 total recess steps for the fall compared to Grade 3 total recess steps for the winter). For all analyses, statistical significance is reported at the <0.05, <0.01, and <0.001 levels.

Results

Average Daily Step Counts Accumulated During Class and Recess Time

Total Daily Steps*:* Students accumulated an average of 5899 (SD:1444.0) steps.

Recess: Students accumulated an average of 2767 steps (SD:804.5) during recess, representing 47% of the average daily steps being accumulated during school hours.

Class Time: Students accumulated an average of 3132 steps (SD:762.9) during class-time, representing 53% of the average daily steps being accumulated during school hours.

Block Scheduling Effects (morning versus afternoon recess)

A comparison of step counts achieved during the morning (AM) and afternoon (PM) recesses are displayed in Table 1. When considering the average 10-day AM and PM recess step counts for each of the following groups: all students; boys; girls; grade 3; and grade 6 students, we found that there is no difference in the number of steps taken, as assessed with the paired t-test. Similarly, no differences were observed in the number of steps taken during the morning and afternoon recesses for either the fall or winter seasons for all groups, with the exception of Grade 6 students in the winter (see Table 1).

[Insert Table 1]

Group Comparisons

Combined Seasonal Averages

Gender: Compared to girls, boys accumulated significantly more steps in both AM recess (boys: 1547 ±342.4; girls; 1121 ±378.0; $p<0.001$) and PM recess (boys: 1549 ±361.1; girls; 1091 ±341.5; $p<0.001$) (see Table 1).

Grade*:* There was no difference in the number of steps accumulated for either the AM or PM recesses for the grades 3 and 6 children (see Table 1).

Fall Step Counts

Gender: Boys accumulated significantly more steps in both AM and PM recesses compared to girls (AM - boys: 1684 ±392.8; girls; 1262 ±486.7; $p<0.001$ / PM - boys: 1656 ±439.4; girls; 1172 ±440.8; $p<0.001$).

Grade*:* Grade 3 students accumulated significantly more steps in both the AM and PM recesses when compared to grade 6 students (AM - grade 3: 1686 ±465.3; grade 6; 1384 ±439.6; $p<0.01$). (PM - grade 3: 1624 ±509.5; grade 6; 1342 ±499.0; $p<0.01$).

Winter Step Counts

Gender: Boys accumulated significantly more steps in the both AM and PM recesses compared to girls (AM - boys: 1383 ±469.1; girls; 971 ±356.7; $p<0.001$ / PM - boys: 1411 ±447.5; girls; 999 ±319.5; $p<0.001$).

Grade: There was no difference in the AM or PM recess when comparing grade 3 to 6.

Seasonal Effects (fall versus winter)

Total Daily Steps*:* Overall, students accumulated significantly more steps, in the fall (6267 ±1652.7) than in the winter (5487 ±1575.9); $p<0.001$). (see Table 2).

Recess: Students accumulated significantly more steps during recess in the fall (3003 ±927.1) compared to the winter (2488 ±890.4; $p<0.001$). (see Table 2).

Class Time*:* Students accumulated significantly more steps during Total In-Class time in the fall (3264 ±891.2) compared to the winter (2999 ±853.5; $p<0.01$). (see Table 2)

Boys: Boys accumulated significantly more steps in the fall compared to the winter for Total Daily steps (fall: 6754 ±1450.2; winter: 5914 ±1581.9, $p<0.001$), for Total Recess steps (fall: 3340 ±799.9; winter: 2794 ±877.1; $p<0.001$), and Total In-Class steps (fall: 3414 ±820.8; winter: 3120 ±847.7; $p<0.01$). (see Table 2)

Girls*:* Girls accumulated significantly more steps in the fall compared to the winter for Total Daily steps (fall: 5445 ±1670.6; winter: 4764 ±1295.8, $p<0.01$) and for Total Recess steps (fall: 2434 ±855.8; winter: 1970 ±647.7; $p<0.01$). There was no significant difference between seasons for Total In-Class steps. (see Table 2)

Grade 3: Children in Grade 3 accumulated significantly more steps in the fall compared to the winter for Total Daily steps (fall: 6755 ±1794.3; winter: 5664 ±1402.8; $p<0.001$), Total Recess steps (fall: 3310 ±949.0; winter: 2411 ±755.2; $p<0.001$). There was no significant difference between seasons for Total In-Class steps. (see Table 2)

Grade 6: Children in Grade 3 accumulated significantly more steps in the fall compared to the winter for Total daily steps (fall: 5827 ±1393.3; winter: 5327 ±1718.8; $p<0.05$) and Total In-Class steps (fall: 3101 ±770.8; winter: 2770 ±865.9; $p<0.01$). There was no significant difference between seasons for Total Recess steps. (see Table 2)

[Insert Table 2]

Group Comparisons Fall Step Counts

Gender: Boys accumulated significantly more steps than girls for Total Daily steps (boys: 6754 ±1450.2; girls; 5445 ±1670.6; $p<0.001$), Total Recess steps (boys: 3340 ±799.9; girls: 2434 ±855.8; $p<0.001$) and Total In-Class steps (boys: 3414 ±820.8; girls: 3011 ±960.9; $p<0.05$).

Grade: Grade 3 students accumulated significantly more steps than grade 6 students for Total Daily steps (grade 3: 6755 ±1794.3; grade 6: 5827 ±1393.3; $p<0.01$) and Total Recess steps (grade 3: 3310 ±949.0; grade 6: 2726 ±823.4; $p<0.01$). There were no significant differences between grade 3 and grade 6 for Total In-Class steps.

Group Comparisons Winter Step Counts

Gender: Boys accumulated significantly more steps than girls for Total Daily steps (boys: 5914 ±1581.9; girls; 4764 ±1295.8; $p<0.01$), Total Recess steps (boys: 2794 ±877.1; girls: 1970 ±647.7; $p<0.001$). There was no significant difference in the winter between boys and girls for Total In-Class steps.

Grade: Grade 3 students accumulated significantly more steps than grade 6 students for Total In-Class steps (grade 3: 3253 ±773.9; grade 6: 2770 ±865.9; $p<0.05$). There were no significant differences between grade 3 and grade 6 for Total Daily steps or Total Recess steps.

Discussion

The aim of this study was to assess how physical activity levels in children from grades 3 and 6 from a northern Ontario elementary school are impacted by the recess schedule of the BSD and by season. Our findings show that the levels of physical activity during recesses are significantly reduced during the winter months particularly for younger students whereas recess scheduling has no impact. Daily total step counts in the present study are similar to those reported by Gauthier and colleagues (2012) further indicating that the school setting is likely not being fully exploited to help children achieve the recommended daily physical activity levels. Results from our study indicate that throughout the day participants accumulated only 52% (6267 steps) of the recommended 12,000 steps in the fall and 46% (5487 steps) in the winter. As data were collected via a segmented approach, we can now report that during recess time participants attain only 25% (3003 steps) of the recommended daily physical activity in the fall and 21% (2488 steps) in the winter. Therefore, unless children are engaged in physical activities outside school hours, the 40 minutes of unstructured play provided by recess periods of the BSD appear to not sufficiently engage students in physical activity levels that are conducive to health and wellness.

Our findings also suggest that boys accumulate more recess-based physical activity than girls which has also been reported in other studies (Beighle, Morgan, Masurier, & Pangrazi, 2006; Ridgers, Fairclough, & Stratton, 2005; Ridgers, Toth, & Uvacsek, 2009; Verstraete, Cardon, Clercq, & De Bourdeaudhuij, 2006; Nettlefold, McKay, Warburton, McGuire, Berdin, Naylor, 2011; Huberty, Siahpush, Beighle, Fuhrmeister, Silva, & Welk, 2011). It has been postulated that these gender differences arise due to the behaviours that each gender engages in at recess time. In particular, it is suggested that boys tend to engage in more competitive and sporting behaviours (Blatchford, Baines, & Pellegrini, 2003) while girls participate more in sedentary play (Blatchford, Baines, & Pellegrini, 2003; Ridgers, Stratton & McKenzie 2010). Accordingly, these results suggest that physical activity interventions targeting the interests of girls to increase their participation in recess-based physical activity are warranted but that boys should also be encouraged to increase their physical activity levels during recess. Furthermore, grade 3 students accumulated more physical activity than grade 6 students. These findings are also consistent with similar studies which have focused on recess-based physical activity (Gauthier, Laurence, Thirkhill, & Dorman, 2012; Ridgers, Saint-Maurice, Welk, Siahpush, & Huberty, 2011). Therefore, strategies to enhance physical activity participation in older students during recess time are also needed.

Although participants did not appear to maximize opportunities for physical activity throughout the day, a fairly ‘balanced’ amount of steps were accumulated during the AM and PM recess time during fall and winter. In other words, children using the BSD are engaging in equal amounts of physical activity in the morning and afternoon recesses but this amount likely remains insufficient to attain healthful levels of physical activity particularly if children are not engaged in activities outside school.

The present study is the first to report the impact of season on recess-based physical activity for students using the BSD. Interestingly, our results clearly demonstrate that season has a strong influence on physical activity levels attained during recess time by children using the BSD schedule. Specifically, step counts are significantly reduced in the winter season. This is particularly worrisome, given that previous studies have shown that declines in activity in the winter months persist into overall declines in subsequent seasons as well (Chan & Ryan, 2009).

The area in which this study was conducted faces a wide variation of weather during the elementary school year. For instance, in October, average temperatures are 5.8°C whereas in February average temperatures are -11.4°C with extreme temperatures as low as -50°C with the wind chill (Environment Canada, 2013). According to Chan et al. (2006) weather conditions can have a great influence on outdoor activities impacting daily steps counts and overall energy expenditure. They postulated that an increase in temperature by 10°C can result in a 2.9% increase in steps per day (Chan, Ryan & Tudor-Locke, 2006). In the present study, students accumulated 515 steps less during recess in the winter and grade 3 students experienced the greatest decrease in steps seasonally, dropping by 899 steps from fall to winter. This suggests that in order to increase recess-based physical activity levels in colder weather, interventions targeting all children but particularly younger students is warranted. For instance, some winter physical education classes could be held outside, focusing on educating children on how to engage in snow-related activities. This would allow for the younger students to become more comfortable and engaged during inclement weather, in turn accumulating more physical activity during recess time. It may also be suggested that indoor play be implemented. The option of playing in the gymnasium during cold weather spells may be more conducive to active play, however this option may only be feasible in schools with a small student population.

Limitations

Pedometers were used in this study because they are commonly used devices for assessing physical activity levels (Bassett & John, 2010). The frequency of pedometer use has increased for children as these devices yield more objective data than traditional self-report instruments such as physical activity logs, diaries and questionnaires (Bassett & John, 2010) These latter subjective measures are less suitable as they require memory recall which when used to record physical activity levels are highly prone to self-reported bias specifically in children (Bassett & John, 2010; Welk, Corbin, & Dale, 2000; Sallis & Saelens, 2000) as a child's cognitive development may impair the ability to provide accurate recall (Baranowski, 1988). Although more reliable than certain survey data, pedometers are limited as they do not assess all aspects of physical activity, specifically duration and intensity of movement. The use of a more comprehensive tool (e.g., accelerometers) would have allowed for a more detailed understanding of the children's activity patterns (i.e. intensity). Furthermore, despite the strong response rate and sample size, the simultaneous assessment of recess-based physical activity at multiple schools using scheduling variations would have been beneficial. The addition of multiple schools, with various school schedules would have allowed for a more comprehensive analysis of the impact of season on recess-based physical activity. In addition, assessing multiple schools at more frequent intervals (not just fall and winter) would have provided a more in-depth analysis of the influence that weather can have on recess-based physical activity. Overall, the inclusion of multiple schools, with varying schedules, over a broader range of weather would allow for a study like this to provide more generalizable results.

Furthermore, the study would have benefited from the collection of additional co-variates. For example, the study focused only on the impact of the general concept of 'season', yet the addition of daily temperature values may have allowed researchers to control for weather conditions. Additionally, controlling for individual predictors of physical activity, such as Body Mass Index, would have also been beneficial. As such, future studies should consider controlling for additional confounding elements.

Conclusions

As a result of this study, we have reaffirmed that children are not maximizing opportunities for physical activity during the school day. In general, lower step counts are noted among girls. We can also conclude that the recess schedule (i.e. morning vs. afternoon) does not affect physical activity during recess in children using the BSD; however, there is a seasonal influence. All children were less active in the winter recess when compared to the fall and this was particularly accentuated among the younger participants. Future studies in this area of research would benefit from including multiple schools using the same organizational system for recess time, in addition to schools using different scheduling systems, and data collection periods throughout various times of the school year; a strategy that would result in more generalizable results.

Implications for School Health

There are four main applied findings from this study. First, strategies to enhance active play during recess, irrespective of time-of-day or season, are warranted as recess time is severely underutilized. Second, this study reaffirms the need for targeted strategies to enhance active play for girls. Third, strategies to mitigate the declines in physical activity during the winter season should be implemented. For example situations where extreme weather conditions apply may warrant physical activity interventions including more organized, inclusive outdoor play or perhaps indoor gymnasium activities. Finally, despite this study suggesting that there is no difference in recess step counts at different times of day, and thus confirming that the BSD is in fact a ‘balanced’ school scheduling system as it relates to comparative physical activity levels, administrators need to consider all aspects affected by modifications of school scheduling. We recommend that administrators work with the research community in order to properly evaluate the impact of any administrative changes on physical activity levels and corresponding health and wellness effects prior to a complete implementation. The adoptions of healthful behaviors during childhood that include exercise and physical activity have long-lasting impacts on physical activity behaviors in adulthood. Schools should recognize their important role and contributions in helping children achieve life-long wellbeing.

Human Subjects Approval Statement

The study protocol was approved by the Laurentian University Research Ethics Board, as well as the School Board in which this school was located.

Table 1. Time of Day Comparison for Step Counts during Recess; Mean (Standard Deviation)

	10-day Mean Step Count			5-day Fall Mean Step Count			5-day Winter Mean Step Count		
	AM	PM	p	AM	PM	p	AM	PM	p
All (N=78)	1388 (409.8)	1379 (416.2)	0.65	1527 (473.9)	1476 (496.3)	0.12	1230 (472.8)	1258 (449.7)	0.31
Boys (N=49)	1547 (342.4)	1549 (361.1)	0.93	1684 (392.8)	1656 (439.4)	0.39	1383 (469.1)	1411 (447.5)	0.46
Girls (N=29)	1121 (378.0)	1091 (341.5)	0.46	1262 (486.7)	1172 (440.8)	0.19	971 (356.7)	999 (319.5)	0.46
Grade 3 (N=37)	1468 (396.4)	1423 (396.1)	0.08	1686 (465.3)	1624 (509.5)	0.11	1226 (451.9)	1185 (338.2)	0.35
Grade 6 (N=41)	1316 (413.1)	1339 (434.5)	0.50	1384 (439.6)	1342 (449.0)	0.42	1234 (496.6)	1323 (526.4)	**0.01**

Table 2. Daily Step Counts by Season; Mean (Standard Deviation)

		Season		P
Sample		Fall	Winter	
All (100%, N=78)	Total	6267 (1652.7)	5487 (1575.9)	**0.001**
	Recess	3003 (927.1)	2488 (890.4)	**0.001**
	Class Time	3264 (891.2)	2999 (853.5)	**0.01**
Boys (62.8%, N=49)	Total	6754 (1450.2)	5914 (1581.9)	**0.001**
	Recess	3340 (799.9)	2794 (877.1)	**0.001**
	Class Time	3414 (820.8)	3120 (847.7)	**0.01**
Girls (37.2%, N=29)	Total	5445 (1670.6)	4764 (1295.8)	**0.01**
	Recess	2434 (855.8)	1970 (647.7)	**0.01**
	Class Time	3011 (960.9)	2794 (838.0)	0.22
Grade 3 (47.4%, N=37)	Total	6755 (1794.3)	5664 (1402.8)	**0.001**
	Recess	3310 (949.0)	2411 (755.2)	**0.001**
	Class Time	3445 (987.2)	3253 (773.9)	0.19
Grade 6 (52.6%, N=41)	Total	5827 (1393.3)	5327 (1718.8)	**0.05**
	Recess	2726 (823.4)	2557 (1001.3)	0.14
	Class Time	3101 (770.8)	2770 (865.9)	**0.01**

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CHAPTER IV

GENERAL DISCUSSION

4.1 Discussion

The aim of this study was to assess how recess physical activity levels in children from grades 3 and 6 using the Balanced School Day are influenced by the time-of-day and season. Our findings show that the level of physical activity during recess is significantly reduced during the winter months, particularly for younger students, whereas time-of-day had no impact. Daily, total step counts in the present study are similar to those previously reported by Gauthier *et al.* (2012), further indicating that the school setting is likely not being fully exploited to help children achieve the recommended daily physical activity. Results from our study indicate that throughout the day participants accumulated only 52% (6267 steps) of the recommended 12,000 steps in the fall and 46% (5487 steps) in the winter. As data were collected via a segmented approach, the 40 minutes available for recess can be seen as the opportunity to attain 2/3rd of the recommended daily steps, or 8000 steps. Therefore, we can now report that during recess time participants attain only 38% (3003 steps) of the recommended daily physical activity in the fall and 31% (2488 steps) in the winter. Therefore, unless children are engaging in adequate physical activity during physical education classes while at school and/or engaged in physical activities outside school hours, the 40 minutes of unstructured play provided by recess periods of the BSD are not sufficient to engage students in adequate physical activity considered to be conducive to health and wellness. Unfortunately, according to a study by Dale and colleagues (2000), children who experience a sedentary school day do not compensate by increasing their physical activity levels after school. With this in mind, it is important that students be encouraged to increase their physical activity levels during school, and more specifically, during recess time.

It is also important to recognize that while school time allocated to PE is limited, recess is scheduled for more periods each day, meaning children have a greater opportunity for physical activity via recess, making it an important school environmental factor for the promotion of PA (Verstraete, Cardon, De Clerq, & De Bourdeaudhuij, 2005). It has been suggested that in general, in order to develop effective physical activity interventions to increase recess-based physical activity in youth, influences on, and determinants of physical activity levels need to be better understood (Sallis, Prochaska, & Taylor, 2000). Therefore, important physical activity influences and determinants will be discussed in an effort to improve recess based physical activity levels.

Nielson, Pfister, & Andersen (2011) reported that the greatest variance in children's physical activity occurs in institutional settings, specifically schools, where children rely on self-organized activities during recess. Identifying factors influencing recess physical activity, with a focus on gender differences, will help inform school policy and development of strategies designed to promote physical activity in school settings (Pawlowski, Tjørnhøj-Thomsen, Schipperijn, & Troelsen, 2014).

On average students engage in moderate-to-vigorous physical activity for less than 50% of recess time (McKenzie et al., 1997). In order to increase this percentage, we must better understand why students are engaging in so little physical activity. One approach to understanding the barriers that influence recess-based physical activity involves going straight to the source: asking students themselves their perspective. Using this strategy, two Australian studies identified that children perceive a lack of facilities/equipment, bullying, school policy, lack of teacher support, clothes (Parrish, Yeatman, Iverson, & Russell, 2012), lack of space, weather (Stanley, Boshoff, & Dollman, 2012), playground aesthetics, lack of fundamental movement skills and recess length (Parrish et al., 2012) as influential barriers to recess physical activity. Although some of these factors are somewhat unavoidable, such as weather and movements skills, others can be manipulated to increase recess-based physical activity levels, such as teacher support, playground aesthetics, school policy and recess length.

4.2. Relevance of the current study

Clearly, our study revealed that students of all ages and both genders are not attaining an optimizing physical activity during recess time. On that note, it is important to discuss ways to increase the physical activity levels of all students by focusing on the factors that are possibly limiting recess-based physical activity accumulation; gender, age, time of day and season.

4.2a Girls' Recess Physical Activity

Our findings suggest that boys accumulate more recess-based physical activity than girls, an observation that has been reported in numerous studies (Nettlefold et al., 2011; Ridgers, Fairclough, & Stratton, 2005; Ridgers, Toth, & Uvacsek, 2009; Ridgers, Saint-Maurice, Welk, Siahpush, & Huberty, 2011; Verstraete et al., 2006). For example, a study by Neumark-Sztainer and colleagues (2003) indicated that 12% of adolescent girls report engaging in zero moderate-to-vigorous physical activity within the last week, compared to only 7% of boys (Neumark-Sztainer, Story, Hannan, Tharp, & Rex, 2003).

Ridgers and colleagues (2005) studied 116 boys and 112 girls, aged 5 to 10, from 23 different schools during recess using accelerometry. They found that without intervention, boys participated in physical activity of higher intensity than girls (Ridgers et al., 2005), and that boys spent 33% of recess participating in physical activity, while girls spent only 23% of their time participating in physical activity.

The trend of insufficient recess physical activity in girls tends to worsen during adolescence; Heath and colleagues (1994) reported up to a 50% decline. This reduction starts at approximately age 10 (Sallis, Alcaraz, McKenzie & Hovell, 1999; Vu, Murrie, Gonzalez, & Jobe, 2006) indicating that as girls age, their declining physical activity may intensify the negative effects of physical inactivity. Preventing this decline in girls' physical activity rates includes assessing factors that influence participation and modify these factors to better engage both genders (Neumark-Sztainer et al., 2003).

One leading theory suggests that these gender differences arise due to the behaviours that each gender engages in at recess time. In particular, it is suggested that boys tend to engage in more competitive and sporting behaviours, while girls participate more in sedentary play overtime accumulating significantly less physical activity (Blatchford et al., 2003). These prominent gender differences may be due to adolescents' perceptions of the benefits of physical activity (Vu et al., 2006). For example, adolescent girls frequently report engaging in physical activity for weight management purposes, while boys report participating for competitive reasons (Tappe, Duda, & Ehnerwald, 1989). Girls are much less likely to perceive that the benefits of exercise outweigh the barriers (Garcia et al., 1995). Due to these reasons, adolescent girls are less likely to participate in many forms of physical activity, such as strengthening activities, walking, biking, and all forms of vigorous physical activity (Tappe et al., 1989). Although these studies focus on adolescents, a slightly older age group, the same factors may be applicable to children.

One of the most effective ways to improve girls' physical activity levels lies in understanding their perceived barriers. Although focusing on a slightly older age group, a study by Neumark-Sztainer and colleagues (2003) reported two main factors influencing girl's physical activity rates: perceived time barriers and lack of support. The first, perceived time constraints, which negatively impact girl's physical activity, should theoretically have been avoided, or at least minimized, with the BSD as recess times are longer than in the traditional school schedule. However, girl's physical activity rates are consistently lower with both schedules. The second factor that Neumark-Sztainer and colleagues (2003) found influencing girl's physical activity rates was the support for physical activity from parents, peers and teachers, which positively affected physical activity rates. This suggests that these support networks in girls' lives play a critical role in encouraging physical activity participation. There is a need to raise awareness amongst these supportive individuals of their positive influence towards improving girls' physical activity levels throughout the day.

In other studies, when specifically asked about perceived barriers to physical activity, adolescent and adult girls reported a variety of factors, including 'worries about appearance after physical activity' (Taylor et al., 2000), feeling "too fat", and not viewing one's self as the "sporty type" (Ball, Crawford & Owen, 2000). When reviewing these perceived barriers, the theme of lowered self-confidence and self-esteem seems prominent. With this in mind, interventions, which focus on raising the self-confidence and self-esteem of adolescent girls may, in turn, increase their daily rates of physical activity. Although these studies focuses on a slightly older population, the results may provide insight regarding younger girls. Duncan (2005) suggests that social support from friends (in comparison to support from siblings and parents) has the strongest effect on increased physical activity. One option is the implementation of bonding games for girls during physical education classes. This may increase the self-esteem of adolescent girls, and teach them new ways of play to utilize during recess time. These trends clearly suggest that physical activity interventions targeting the interests of girls to increase their participation in physical activity are warranted but that boys should also be encouraged to increase their physical activity levels during recess.

4.2b Student Age

Our results indicated that grade 3 students accumulated significantly more physical activity than grade 6 students. These findings are consistent with similar studies that have focused on physical activity in elementary school-aged children (Gauthier et al., 2012; Ridgers et al., 2011). Therefore, strategies to enhance physical activity participation in older students are also needed.

More specifically, Gauthier and colleagues (2012) assessed the physical activity patterns of 117 students in grades 3 to 6 and found that students in grade 3 accumulated significantly more steps throughout the school day than students in grades 5 and 6. Ridgers and colleagues (2011) assessed the recess physical activity of 210 grade 3 to 6 children in four elementary schools using uni-axial accelerometry over five consecutive days. This study revealed that during recess grades 3 and 5 students were more active than grades 4 and 6. Clearly, with some variety, the main trend is that younger students are more active than older ones. This may present an opportunity to develop interventions that target older elementary students. Specifically asking these students about their perceived barriers to recess-based physical activity may shed light on the cause behind the evident trend for a decline in daily physical activity rates that develops as children age.

4.2c Recess Time-of Day and Season

Although participants did not appear to maximize opportunities for physical activity throughout the day, a fairly 'balanced' amount of steps were accumulated during the AM and PM recess time during fall and winter. In other words, children using the BSD are engaging in equal amounts of physical activity in the morning and afternoon recesses, but this amount likely remains insufficient to attain healthful levels of physical activity particularly if children are not engaged in activities outside school.

The present study is the first to report the impact of season on recess-based physical activity for students using the BSD. Interestingly, our results clearly demonstrate that season has a strong influence on physical activity levels attained during recess time by children using the BSD schedule. Specifically, step counts are significantly reduced in the winter season. This is particularly worrisome, given that previous studies have shown that declines in activity in the winter months persist into overall declines in subsequent seasons as well (Chan et al., 2009).

The area in which this study was conducted faces a wide variation of weather during the elementary school year. For instance, in October, average temperatures are 5.8°C whereas in February average temperatures are -11.4°C with extreme temperatures as low as -50°C with the wind chill (Environment Canada, 2013). According to Chan et al. (2006) weather conditions can have a great influence on outdoor activities impacting daily steps counts and overall energy expenditure. They postulated that an increase in temperature by 10°C can result in a 2.9% increase in steps per day (Chan et al., 2006). In the present study, students accumulated 515 steps less during recess in the winter and grade 3 students experienced the greatest decrease in steps seasonally, dropping by 899 steps from fall to winter. This suggests that in order to increase recess-based physical activity levels in colder weather, interventions targeting all children but particularly younger students is warranted. For instance, some winter physical education classes could be held outside, focusing on educating children on how to engage in snow-related activities. This would allow for the younger students to become more comfortable and engaged during inclement weather, in turn accumulating more physical activity during recess time. It may also be suggested that indoor play be implemented. The option of playing in the gymnasium during cold weather spells may be more conducive to active play; however this option may only be feasible in schools with a small student population. This information should be highlighted by policy making to ensure adequate gym space for each student, particularly in schools located in geography extremes.

Pawlowski, Tjørnhøj-Thomsen, Schipperijn, and Troelsen (2014) investigated the perspectives of students regarding the impact of weather on physical activity during recess. From this study, they found that children do not think it is fun to play in the rain or snow, and that such weather would stop them from using fields, equipment and courts. Girls were especially subject to this view, stating that they would much prefer participating in indoor, sedentary activities as opposed to spending recess outside during poor weather conditions. On the other hand, many boys did not seem to be swayed from outdoor physical activity in the face of undesirable weather. Clearly, as girls already have insufficient accumulation of physical activity during recess even in favourable weather, interventions to increase their physical activity during recesses subjected to inclement weather may be warranted.

4.3 Increasing Recess-Based Physical Activity

Along with targeting specific factors to increase recess physical activity, general adaptations can be made within the school environment. These adaptations can focus on the social environment, in ways such as social prompts and encouragement to be physically active, or on the physical environment, including games equipment, and play facilities.

4.3a Interventions Focusing on Social Prompts

Social prompts, aimed at placing a positive emphasis on physical activity, have recently been utilized in an effort to increase recess-based physical activity levels. Although focused on slightly younger children, a study by McKenzie et al., (1997) revealed that social prompts including positive, verbal encouragement to be physically active by both adults and peers increased recess physical activity levels of students. This study focused on 287 students before and after a two-year period. During this time teachers were taught how to provide social prompts for physical activity, as were the students involved. As time elapsed, teacher prompts were reduced in an effort to assess the level of peer-to-peer support. It was evident that boys provided social prompts for physical activity to other boys, but girls did not. This is particularly worrisome as Duncan (2005) suggests that social support from peers has the strongest effect on increasing girls' physical activity. This may suggest that educating teachers to encourage children to be more active during recess may directly increase student daily step counts, yet specific effort should be placed on encouraging girls' peer social prompts.

4.3b Interventions Focusing on School Provided Equipment

One intervention that has shown to improve the accumulation of physical activity during recess is the introduction of play equipment supplied by the school (Verstraete et al., 2005). In one study by Vertraete and colleagues (2005), four schools, with a total of 122 students, received activity cards which provided examples of games, and game equipment including jump ropes, balls, hoola hoops, frisbees, badminton rackets, juggling balls, and other various games equipment. Additionally, three schools, with 113 students were assigned as a control group. The researchers assessed the physical activity levels of both groups via accelerometers prior to the intervention and three months post intervention. They found that the group that was exposed to the intervention increased their physical activity during recess from 48% to 61%, and the control group actually declined their activity during recess from 55% to 45%. More specifically, the intervention increased students' moderate intensity physical activity. During lunch recess (the longer break) this intervention was effective for both boys and girls, yet during the shorter morning and afternoon recesses it was only effective for boys. This suggests that the provision of games equipment may increase girls' physical activity levels, as both recesses in the BSD are longer in duration, more like the lunch recess of the traditional school day.

When considering the addition of play equipment to increase recess physical activity levels, the type of play equipment one is introducing should be considered. For example, Zask and colleagues (2001) have reported that the level of physical activity attained during recess is directly linked to the number of balls available per child. On the other hand, another interesting study, performed by Bundy and colleagues (2009) reported that introduction of non-traditional equipment (ex. tires, cardboard boxes) not only increased recess-based physical activity levels, but also increased student sociability, creativity and resilience. The study indicated that although teachers perceived the new environment to pose an increased risk to child safety, no injuries were reported throughout the study. These two studies show that no matter what type of play-equipment students are provided with, physical activity levels will likely be improved.

4.3c Playground Markings

Several recent studies have observed recess-based physical activity improvements attained when colourful playground markings are introduced to recess area equipment (Stratton, 2000; Stratton & Mullan, 2005). For example, a Stratton (2000) utilized heart rate telemetry to assess playtime physical activity levels of 47, five-to-seven year olds before and after existing playground equipment was painted with bright markings. Students participating in this study spent an average of 28 minutes in moderate-to-vigorous physical activity prior to painting, and increased this to an average of 40 minutes engaging in MVPA after the equipment was painted.

Similarly, Ridgers and colleagues (2007) assessed the effectiveness of bright playground markings by providing 15 schools within one city in England with funding allocated towards redesigning their playground areas based on a multi-coloured zonal design. This design involved dividing the playground into three areas, one red for sports, one blue for multi-activity play, and one yellow for quiet play. In order to compare to children without coloured playgrounds, 12 other schools were used as controls. During recess time student physical activity was assessed via accelerometers and heart rate telemetry. This study revealed that students provided with colourful playground equipment engaged in 4.5% more moderate-to-vigorous physical activity, and 2.3% more vigorous physical activity than those without.

Stratton and Mullen (2005) also completed a study assessing the influence of colourful playground markings on recess physical activity levels. This study focused on 99 students from eight schools. Within these eight schools, four maintained their unmarked playgrounds, and four matched schools received colourful playground markings. Results from this study revealed that the students exposed to the brightly coloured playgrounds experienced a significant increase in physical activity, yet those students at control schools did not. Stratton and Mullen (2005) suggested that painting playgrounds is a low-cost method to increase children's daily physical activity levels.

These studies have revealed that colourful playground markings result in an increase in moderate-to-vigorous, and vigorous physical activity in both the short and long term (Ridgers, Stratton, Fairclough, & Twisk, 2007; Stratton, 2000; Stratton & Mullan, 2005). Interestingly, this increase in recess physical activity was predominant in children who were less physically active at baseline, a result that goes against the theory that less active children often remain less active than their more active peers (Pate et al., 1996). Clearly, this low cost intervention may be one way to increase the physical activity levels of children who are currently physically active, but even more importantly, those who are currently inactive and at a higher risk for morbidity and mortality.

4.4 Implications for School Health

There are four main applied findings from this study. First, strategies to enhance active play during recess, irrespective of time-of-day or season, are warranted as recess time is underutilized. Second, this study reaffirms the need for targeted strategies to enhance active play for all children, but particularly for girls. Third, strategies to mitigate the declines in physical activity during the winter season should be implemented. For example situations where extreme weather conditions apply may warrant physical activity interventions including more organized, inclusive outdoor play or perhaps indoor gymnasium activities. Finally, despite this study suggesting that there is no difference in recess step counts at different times of day, and thus confirming that the BSD is in fact a 'balanced' school scheduling system as it relates to comparative physical activity levels, administrators need to consider all aspects affected by modifications of school scheduling. We recommend that school administrators work with the research community in order to properly evaluate the impact of any administrative changes on physical activity levels and corresponding health and wellness effects prior to a complete implementation. The adoptions of healthful behaviors during childhood that include exercise and physical activity have long-lasting impacts on physical activity behaviors in adulthood. Schools should recognize their important role and contributions in helping children achieve life-long wellbeing.

4.5 Limitations

Pedometers were used in this study because they are commonly used devices for assessing physical activity levels (Bassett & John, 2010). The frequency of pedometer use has increased for children as these devices yield more objective data than traditional self-report instruments such as physical activity logs, diaries and questionnaires (Bassett & John, 2010). These latter subjective measures are less suitable as they require memory recall which when used to record physical activity levels are highly prone to self-reported bias, specifically in children (Bassett & John, 2010; Welk, Corbin, & Dale, 2000; Sallis & Saelens, 2000) as a child's cognitive development may impair the ability to provide accurate recall (Baranowski, 1988). Although more reliable than certain survey data, pedometers are limited as they do not assess all aspects of physical activity, specifically duration and intensity of movement. The use of a more comprehensive tool (e.g., accelerometers) would have allowed for a more detailed understanding of the children's activity patterns (i.e. intensity).

Furthermore, despite the strong response rate and sample size, the simultaneous assessment of recess-based physical activity at multiple schools using scheduling variations would have been beneficial. Additionally, the simultaneous comparison of several schools utilizing the Balanced School Day schedule, along with several using the Traditional School Day schedule within a similar geographical area would have been ideal. This would have allowed for a more direct comparison of students exposed to identical weather conditions.

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CHAPTER V

CONCLUSIONS & FUTURE DIRECTIONS

5.1 Conclusions

As a result of this study, we have reaffirmed that children are not maximizing opportunities for physical activity during the school day. In general, lower step counts are noted among girls and grade 6 students. We can also conclude that the time-of-day (i.e. morning vs. afternoon) does not affect physical activity during recess in children using the BSD; however, there is a seasonal influence. All children were less active in the winter recess when compared to the fall and this was particularly accentuated among the younger participants.

Regular, adequate physical activity in childhood and adolescence can result in the improvement of both physical and mental health in the present and in the future. The risks of developing cardiovascular disease, diabetes, hypertension, poor lipoprotein profiles, and obesity are all lessened with adequate exercise. Unfortunately, children are not acquiring sufficient amounts of physical activity, resulting in less healthy children, as well as less healthy adults in the future.

This is the first study to specifically assess physical activity levels during recess for students using the Balanced School Day. This is an important research subject as many schools throughout Ontario, Manitoba and Alberta have adopted this schedule with the assumption that it will improve students' physical activity levels. Unfortunately, there is currently no evidence to support this notion. Work by Gauthier and colleagues (2012) suggested that students using the traditional school day acquire higher step counts than those with the BSD. This study suggested that students using the BSD are only attaining 47% of the recommended step count throughout the entire school day, while those using the TSD are accumulating 50%.

As a result of our study we can confirm that the Balanced School Day does lead to equal amounts of physical activity when comparing the morning and afternoon recess. However, there is a clear inadequacy when comparing fall and winter recess time. This suggests that school policies should include interventions that focus on increasing and maintaining physical activity levels of students during the winter months.

Some ways to improve recess physical activity levels are the introduction of school provided game equipment, brightly coloured playground markings, and adequate social prompts. Additionally, it is suggested that outdoor winter games should be introduced in physical education classes, in an effort to teach children how to better play in the snow in hopes of this knowledge transferring to recess time. These interventions have been proven to increase both the amount and intensity of recess physical activity.

Another area that needs more attention is the low physical activity levels among girls. Levels of physical activity are girls consistently lower than in boys. In addition, girls' physical activity levels more intensively declines with age. Females tend to engage more in social play during recess time, and perhaps games involving socialization and physical activity may improve their physical activity levels. By encouraging girls to play, and sparking their interest in physical activity at a young age, we may be able to allow them to attain adequate levels of physical activity throughout their lives thereby improving health later in life.

It is clear that overall, physical activity levels of students during recess need to be improved in order to ensure optimal physical, mental and social health. This study is the first step in understanding the implications of school scheduling on recess physical activity.

5.2 Future Directions

Researchers must continue to focus on the factors that play a role in recess-based physical activity. One way to accomplish this is to compare the recess-based physical activity accumulation of students using the Balanced School Day and the traditional school day schedules simultaneously. This would require the inclusion of at least one BSD school and one TSD school in a similar area of similar socio-economic status.

Another area of research that would be beneficial to the health of students in this field or research is the assessment of winter based physical activity interventions. These types of interventions have not yet been extensively researched, but if effective would aid in maintaining student physical activity levels through the school year, hence positively impacting any seasonal declines in activity levels. Teaching children how to play in the snow will help them stay active throughout their lives.

In sum, researchers should continue to assess the factors that influence recess based physical activity levels, and their interventions. In order to ensure healthy growth and development, we must ensure that students are provided with the necessary skills to engage in, and enjoy, healthful amounts of physical activity during school. This will prepare them to remain active late into their adult life.

APPENDICES

List of Appendices;

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Appendix A: Research Ethics Board Approval

APPROVAL FOR CONDUCTING RESEARCH INVOLVING HUMAN SUBJECTS

Research Ethics Board – Laurentian University

This letter confirms that the research project identified below has successfully passed the ethics review by the Laurentian University Research Ethics Board (REB). Your ethics approval date, other milestone dates, and any special conditions for your project are indicated below.

TYPE OF APPROVAL / New / Modifications to project X/ Time extension

Name of Principal Investigator and school/department	Alain Gauthier
Title of Project	A Study on School Scheduling: Implications for Physical Activity
REB file number	2012-01-14
Date of original approval of project	February 23, 2012
Date of approval of project modifications or extension *(if applicable)*	August 1, 2012
Final/Interim report due on: *(You may request an extension at that time using this weblink)*	August 1, 2013
Conditions placed on project	Final report due on August 1, 2013

During the course of your research, no deviations from, or changes to, the protocol, recruitment or consent forms may be initiated without prior written approval from the REB. If you wish to modify your research project, please refer to the Research Ethics website to complete the appropriate REB form.

All projects must submit a report to REB at least once per year. If involvement with human participants continues for longer than one year (e.g. you have not completed the objectives of the study and have not yet terminated contact with the participants, except for feedback of final results to participants), you must request an extension using the appropriate REB form.

In all cases, please ensure that your research complies with Tri-Council Policy Statement (TCPS). Also please quote your REB file number on all future correspondence with the REB office.

Congratulations and best of luck in conducting your research.

Susan James, Acting chair

Laurentian University Research Ethics Board

Appendix B: School Report

Does weather impact physical activity levels in children during recess?

Children should participate in 60 minutes of physical activity each day. Canadian researchers estimate that this is about 12,000 steps per day[1]. Recess is an important time during the school-day, because it is a chance for children to achieve these steps. However, recess is generally an outdoor activity and in Canada, weather can limit the amount of time that children have for recess. Most schools in Ontario have two 20-minute recesses, one in the morning and one in the afternoon.

The purpose of our study was to see how weather affected the number of steps children in grades 3 and 6 took when at school. We compared total steps taken during recess time, in October to February. We also compared the steps taken in the morning recess to the afternoon recess.

To do this, we collected data in your child's school for 5 days in October, 2012 and in February, 2013. Participating children wore pedometers (a device that counts 'steps') and we separated step counts into sections:

1) steps taken during *class-time*;
2) steps taken during *physical education* (i.e. phys-ed or gym);
3) steps taken during *recess-time*.

78 students participated in this study (out of a possible 124, grade 3 and grade 6 students).

Total Daily Step Counts

- Students took, on average ***5899*** steps each day (class time: 2233 (38%); phys-ed: 899 (15%); recess: 2767 (47%)
- Children had phys-ed class, on average, ***5 times*** over the ten-day period of data collection.

Morning vs. Afternoon Recess

- The number of steps taken during the morning recess compared to the afternoon recess were the same.

Fall vs. Winter Recess

- Students took more steps in the fall: ***6267***, compared to the winter: ***5487***.
    - During fall recess, students took 3003 steps, compared to winter recess steps of 2488.
    - Boys took more steps than girls during recess in both the fall (boys: 3340; girls: 2434) and winter (boys: 2794; girls: 1970).
    - Recess step counts of Grade 3 students dropped more severely than grade 6 students during the winter. Grade 3 steps fell by ***899*** steps between October and February.

Recommendations

Based on what we measured, we think that recess step counts are affected by season and we think this is mostly true for younger children.

We also think that we should try to prevent these declines in activity levels. We suggest the following:

1) Planning inclusive- organized outdoor play
2) Planning indoor play, in advance, for harsh winter days
3) Ensuring children get a minimum of *20-minutes of Daily Physical Activity* in addition to recess time, this should include daily physical education.

1. Colley RC, Janssen I, Tremblay MS. Daily step target to measure adherence to physical activity guidelines in children. *Med Sci Sports Exerc*. 2012; 44(5): 977-82.

This study was conducted by the Laurentian University Nutrition, Physical Activity and Community Health Research Group (LUNCH)- School of Human Kinetics.

L.U.N.C.H
Research Group

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Appendix C: Data Collection Form (Example)

Data Collection Sheet Example

Class: 6A Day 1 Date: ________________ Researcher:___________

Student 40	8:35	10:35	10:55	12:45	1:05	2:55
	Start Day	Go to Recess	Come In	Go to Recess	Come In	End of Day
Pedometer Step Count						
Accelerometer Step Count						
Miles						
Energy Expenditure						
Time Active						

Notes: